Reviews

Geology of the Yellowstone National Park. Part II. Descriptive Geology, Petrography, and Paleontology. By ARNOLD HAGUE, J. P. IDDINGS, W. H. WEED, C. D. WALCOTT, G. H. GIRTY, T. W. STANTON, and F. H. KNOWLTON. Washington: Government Printing Office, 1899. Pp. xviii + 893, 121 plates and 4 figures. Monograph XXXII of the United States Geological Survey.

This compendious monograph is about equally divided between petrography and paleontology, having about 440 pages of text in each division, and of the 121 plates 62 are given to fossils, and 59 and the four figures to petrography and geology. Of the fourteen chapters Iddings furnished seven on the petrography, Iddings and Weed two on the geology, Weed and Hague each one on the geology. Walcott's work on the Cambrian fossils and Girty's on the Devonian and Carboniferous go into one chapter. Stanton furnishes one on the Mesozoic fossils and Knowlton one on paleobotany.

The first chapter, by Iddings and Weed, is on the descriptive geology of the Gallatin Mountains, which mountains extend eighteen miles within the boundary of the park. The diversity of the geological features in this area is remarkable. The sedimentary rocks begin with the Cambrian and range through the Silurian, Devonian, Carboniferous, and Juratrias into the Laramie division of the Upper Cretaceous. Cutting through the sedimentary series are intrusions of igneous masses in the form of laccoliths, sheets, and dikes. The sedimentary rocks are slightly folded and strongly faulted. Extensive erosion has exposed large areas of the rocks in their structural relations. To still add to the diversity, the surface has been glaciated.

The second chapter describes the intrusive rocks of the Gallatin Mountains. These consist mainly of fine-grained, aphanitic masses, mostly porphyritic and andesitic in character. The Indian Creek laccolith is hornblende-mica-andesite-porphyry. The Bighorn Pass sheet

consists of kersantite of complex composition; the Gray Mountain mass and connected sheets consist of andesite and andesite-porphyries. The Mount Holmes bysmalith, Gallatin River laccolith, and the Bunsen Peak mass are composed of dacite-porphyry.

Chapter three deals with Electric Peak and Sepulchre Mountain, which are described as parts of a Tertiary volcano faulted across the neck with a vertical throw of more than 5000 feet. The deeper parts of the volcano consist of sedimentary strata cut by dikes, sheets, and the stock or conduit of the volcano. The ejected breccia and lava flows, along with the upper portion of the conduit, make up Sepulchre Mountain. The andesitic lavas of Sepulchre Mountain change to diorites and porphyries in Electric Peak. Rocks with the same chemical composition in one place crystallize into diorites and in another place form andesites. Both types are illustrated by photomicrographs and photographs. Maps and section illustrate fully the relations of the different rocks.

The northern end of the Teton range, which occurs in the southern part of the park, is described at length in the next chapter. This range is made up of a nucleus of crystalline schists and gneisses, which are overlain by flexed and faulted Paleozoic and Mesozoic strata. The eroded edges of these old sedimentary rocks were covered with volcanic basic breccias and after another period of erosion an extensive outflow of acidic lava covered the whole area and still conceals the northern extremity of the Teton Mountain.

Mr. Hague, in chapter five, describes the irregular diversified mountainous area known as Huckleberry Mountain and Big Game Ridge. It lies in the southern part of the park and in the Forest reservation and consists of a number of northwest-southeast ridges, composed mostly of Mesozoic rocks. The Cretaceous sandstones are the prevailing rocks, but small areas of older strata are exposed. The rhyolites of the park plateau abut against the slopes of the upturned edges. Besides Huckleberry Mountain and Big Game Ridge, there are other elevations known as Wildcat Peak, Bobcat Ridge, Chicken Ridge, and Two Ocean Plateau. The principal igneous rocks in the area are dacites, surrounded by apparently younger rhyolite. In the gorge of the Snake River the Madison limestones, Teton sandstones, Ellis limestones, and shales are exposed. The Snake River hot springs occur near the contact of the rhyolite with the limestones. The travertine deposits around the springs resemble those around the Mammoth Hot Springs

and the lime is derived from the Madison limestone. The Laramie strata are exposed near the base of Pinyon Peak, as shown by the characteristic Wolverine flora. The conglomerate of Pinyon Peak is probably Eocene, as it underlies the basic breccias of the Absaroka range and overlies unconformably the Laramie sandstones. Outlet Canyon, the picturesque gorge cut through Chicken Ridge, at one time served as an outlet into Snake River for the waters of Yellowstone Lake. The Yellowstone Canyon now furnishes an outlet for these waters into the Atlantic, instead of into the Pacific. Two Ocean Plateau, which rises 10,000 feet above the sea level, forms a part of the Absaroka Range. It is made up of volcanic breccias and tuffs.

Chapter six describes the southern end of the Snowy range, which forms the northeast corner of the park. It consists of a broad core of crystalline rocks, bordered by Paleozoic rocks, which dip away from the crystalline axis. Detailed sections of the Paleozoic sedimentary rocks are given, but the igneous rocks are described in other chapters.

Chapter seven is especially interesting to petrologists, as it describes in detail the structural features and petrographic characteristics of a dissected volcano in the Crandall Creek basin. It lies on the border of the park forest reservation and east of the park proper. The great value to petrology lies in the clear delineation of the inside of a volcano, and in giving additional field evidence of the gradation of coarsely crystalline so-called Plutonic rocks into the glassy eruptives. "The coarsely crystalline gabbros and diorites, with smaller bodies of granite, exposed for a height of 3000 feet, are plainly seen to have been intruded into a vast accumulation of basaltic tuff and scoriaceous breccia. From this coarsely crystalline mass as a center, dikes of fine-grained rock penetrate the surrounding lavas in all directions, the dike rocks becoming fine-grained rapidly as they leave the once heated core. They form a network of branches which connect the outlying aphanitic and characteristically volcanic rocks with the more crystalline dikes near the core which finally merge into the granular body of the gabbro and dorite." The whole forms one complex network so closely interwoven that the gabbros of the core are as truly volcanic as the glasses on the surface. The volcano has built itself upon a ridge of eroded Paleozoic rocks, and beneath the volcano are remnants of Eocene breccias and lava flows.

The next chapter treats of the Absaroka range which consists mainly of volcanic breccias with smaller quantities of massive flows. It contains

an account of their field occurrence and distribution, and a systematic description of their mineralogical composition and characteristics. The oldest rocks occur at the north end and consist of acid breccias found in remnants underlying early basic breccias. The former consist mainly of hornblende-andesite and hornblende-mica-andesite. The basic breccias consist of pyroxene-andesite, passing upward into basalt. Upon these were thrown other acid breccias, similar in composition and appearance to the earlier ones. These grade upwards into later basic breccia, consisting of andesites with less basalt than occurs with the earlier flows. This last basic breccia forms the southern portion of the range within the park and also the Two Ocean Plateau. Remnants of surface flows of massive andesite form the summits of Mt. Stevenson, Mt. Doane, Colter Peak, and several prominent mountains south of Sylvan Pass.

Chapters nine, ten, and eleven discuss different classes of the volcanic rocks. The Absarokite-Shoshonite-Banakite series consists of certain basaltic and other rocks associated with andesitic breccias and basalt flows which have considerable orthoclase and a comparatively high percentage of potash. They occur as lava flows and dikes in various localities. They have been classified according to their chemical and mineral composition.

The rhyolites in the park are almost wholly extrusive lavas of uniform chemical composition, but differing widely in color, texture, and megascopic habit. The mode of occurrence, and the microscopic features of phenocrysts, spherulites, lithophysae, are described in detail, and beautifully illustrated. The modifications of crystallization, lamination and the formation of pumice are referred to heterogeneity of the molten magma, especially with reference to the amount of vapors contained in it. In some places basalt appears to have been inclosed and partly fused by the rhyolite.

The recent basalts are distinguished from the early brecciated ones by being ophitic and non-porphyritic. They overlie the rhyolite in most cases, but in some places they occur beneath it, and in some places between the older and younger sheets of rhyolite.

With chapter twelve begins the paleontologic part of the work. The Director of the survey describes the Cambrian fauna from which twenty-one species have been obtained. Several of these are new, and are here described and illustrated for the first time. No fossils of undoubted Silurian age have been obtained. The Devonian is

represented in the Three Forks limestone. A varied but wholly Lower Carboniferous fauna has been obtained from the Madison limestone.

In chapter thirteen Mr. Stanton describes the Mesozoic fossils. These were obtained from the Gallatin range, near Electric Peak, Teton range, in the vicinity of Wildcat Peak and Huckleberry Mountain, and from the Cretaceous ridges in the southern end of the park and Yellowstone Forest Reserve. There are seventy-eight invertebrates, one of which is supposed to be of Triassic age, forty-six are Jurassic, and thirty-two are Cretaceous. The fossils are mainly from the Ellis division of the Jurassic and the Colorado of the Cretaceous.

The last chapter, by Mr. Knowlton, on the fossil flora, is a long one, covering 233 pages, besides 45 plates of illustrations. The Mesozoic flora is confined to the Laramie sandstones of the Cretaceous, and is found on Mt. Everts, near Mammoth Hot Springs, and at the base of Pinyon Peak, near the head of Wolverine Creek. The Tertiary flora is quite varied, and full of biological interest. On comparing it with the present it signifies great climatic changes since the Miocene. It is found in numerous localities associated with the breccias and silts of the igneous rocks, where the muds and silts furnished a soil favorable to plant growth. The Tertiary fossil flora embraces about 150 forms in thirty-three orders. The interesting fossil forest trees of Specimen Ridge are illustrated with photographs of the trees in the field and enlarged microscopic sections showing the cellular structure.

The petrographical and paleontological features of the Yellowstone National Park are certainly described in great detail, and the monograph will no doubt prove to be a valuable handbook to scientists, especially to those visiting the region.

T. C. H.

Report on the Geology and Natural Resources of the Area included by the Nipissing and Temiscaming Map Sheets, comprising portions of the district of Nipissing, Ontario, and of the county of Pontiac, Quebec. By ALFRED ERNEST BARLOW. Geological Survey of Canada. Part I, Annual Report. Vol X, 1899, pp. 302.

This report, accompanied by two well-executed maps on a scale of four miles to the inch, and covering an area 6912 square miles of the northern Protaxis of the Dominion of Canada, is a valuable addition to the literature of the pre-Cambrian of North America and is a further